Foundation Copy

Washington State Department of Transportation

Memorandum

Date: August 19, 1998

From: T. M. Allen/R. E. Kimmerling
OSC Materials Laboratory, 47365
Geotechnical Services Branch
Phone: 360-709-5451
(FAX 360-709-5585)

Subject: SR 167, C.S. 1766, 0L-2305
15th Ave. SW to 15th Ave. NW - Stage 3
Soil Nail Wall Recommendations
Wall 7

To: M. M. Lwin/R. Zeldenrust
Bridge & Structures Office
MS 47340

We have reviewed the "shelf" plans for the subject wall to be constructed to support the removal of the end slope in front of Pier 1 of the 180th Ave. Undercrossing. We have found that in the time since the design was put on the "shelf" the standard of practice for design of soil nail walls has changed sufficiently to warrant re-design of the wall. This memo provides our recommendations for re-design of the wall and supersedes the recommendations previously provided by Shannon & Wilson, dated 2/20/93.

Attached are marked up drawings reflecting the new design. The following are the major changes which should be considered in preparing the revised Plans and Special Provision:

1. The required nail head strength is reduced to an ultimate value of 36 kips. The nail head strength factors shown in Table 4.4 of the Manual for Design and Construction of Soil Nail Walls (FHWA-SA-96-069) should be used to check the size, spacing and distribution of the permanent C.I.P facing.

2. The attached marked-up Plans show the new nail lengths and required bar sizes. The horizontal spacing of the nails has not been changed.

3. Fully encapsulated bars should be used for the nails which support the abutment beneath the bridge. The Special Provision should be modified as indicated in the attachment. A detail for fully encapsulated soil nails was previously developed by the Bridge Office which was a modification of the permanent ground anchor details. This should be included in the Plans.

The construction clearance for the top row of nails is marginal, but it is felt that small drill rigs should be able to install the nails with the flattened declination angle of 10 degrees for the top row. The re-design should result in a more constructable wall since the nail lengths are shorter and should be able to be inserted in the nail holes without interference from the bridge superstructure.

If you have questions or require further information, please contact Robert Kimmerling at (360) 709-5451.

TMA:rek
REK

cc: C. C. Ruth, MS 47340 (no attachments)
Y. A. Mhatre, MS 47340 (no attachments)
J. Johnson/K. Ezeokeke, MS NB82-143
T. Smith, MS NB82-29

SOIL NAILING

Description

This work shall consist of constructing soil nail walls.

Materials

Materials for construction of the soil nailed structure shall consist of the following:

Soil Nails

All reinforcing bars of the soil nails shall conform to Section 9-07 and these Special Provisions. The bars shall be AASHTO M 31, Grade 60, or High Strength AASHTO M275 TYPE II as specified in the Plans.

Soil nail bars shall be of the type and size specified in the Plans. The bars shall not be spliced. The bars shall be threaded at the bearing plate end a minimum of six inches. The threading shall be continuous spiral deformed ribbing. Alternatively, threads may be cut into the reinforcing bar if the bar size is increased to the next larger size from the size shown in the Plans at no additional cost to the Contracting Agency.

Corrosion Protection

All soil nail bars shall be epoxy coated or fully encapsulated for corrosion protection.

Epoxy-corrosion protected soil nails shall conform to the requirements of AASHTO M31 and M284 and Section 6-02.3(24)H.

A. When the Plans require the ~~tendon~~ bar to be encapsulated to provide additional corrosion protection, the encapsulation shall be fabricated from one of the following:

1. High density corrugate polyehtylene (PE) tubing conforming to the requirements of AASHTO M 252 and having a minimum wall thickness of 30 mils.
2. Corrugated, polyvinyl chloride (PVC) tubes as provided by Dywidag Systems International or approved equal.

Bearing Plates

Bearing plates shall be as specified in the Plans and fabricated from steel conforming to AASHTO M 183.

Centralizers

Centralizers shall be fabricated from plastic, steel, or material non detrimental to the nail steel. Wood shall not be used. The centralizers shall provide a minimum of 0.5 inch of grout cover over the bar. Centralizers shall be spaced no further than 8 feet apart.

Nuts

Nuts shall conform to AASHTO M291, Grade B, Hexagonal. The nuts shall be fitted, where necessary, with a special washer or spherical seat such that the nut will bear uniformly on the plate.

Reinforcing Steel

Deformed steel bars and welded wire fabric used in the shotcrete facing shall conform to Section 9-07.

Shotcrete (Air Placed concrete)

Shotcrete shall conform to the requirements specified in the Special Provision SHOTCRETE WALL FACING.

Concrete

Concrete used in the construction of concrete fascia wall shall be Class 4000 and shall conform to Section 6-02.

The finish of the concrete fascia wall shall conform to the requirements of the Special Provision **PIGMENTED SEALER.**

Prefabricated Drainage Material

The Prefabricated Drainage Material shall have a single or double dimpled polymeric core ~~of high impact polystyrene~~ with a non-woven geotextile attached and meet the following requirements:

Property	Test Method	Prefabricated Drainage Material/Geotextile Property Requirements
Width		0.3 m (12 inches) min.
Thickness	ASTM D 5199	10 mm (0.4 inches) min.
Compressive Strength at Yield	ASTM D 1621	700 kPa (101 psi) min.
In Plan Flow Rate Gradient = 0.1, Pressure = 5.5 psi	ASTM D 4716	0.001 m^2 /~~min.~~ sec. (0.01 $ft.^2$ /min.)

Gradient = 1.0,		0.003 m^2/sec. ~~0.0008 m^2/min.~~
Pressure = 14.5 psi		(0.00 9 $ft.^2$ /min.)
Geotextile - AOS	ASTM D 4751	0.25 mm (#60 US Sieve) max.
Geotextile - Permittivity	ASTM D 4491	$\geq$ 0.4 SEC^{-1}
Geotextile - Grab Strength	ASTM D 4632	Nonwoven - ~~530~~ 490 N (~~120~~ 110 lb.) min.

Acceptance shall be based on the Manufacturer's Certificate of Compliance certifying that the material meets the requirements specified.

Installation shall be in accordance with the manufacturer's recommendations.

Construction Requirements

General Description

Soil nailing shall consist of excavating to the layer limits shown in the Plans, drilling holes at the specified angle into the native material, placing and grouting epoxy coated steel bars (soil nails) in the drilled holes, placing prefabricated drainage material and steel reinforcement, and applying a shotcrete facing over the steel reinforcement. After completion of the wall, the Contractor shall construct the permanent concrete fascia in accordance with the Plans and these Special Provisions.

All proprietary items used in the soil nailed structure shall be installed in accordance with the manufacturer's recommendations. In the event of a conflict between the manufacturer's recommendations and these Special Provisions these Special Provisions shall prevail.

Contractor's Experience Requirements

Within the last five years, the Contractor performing this work shall have successfully completed at least five projects involving construction of retaining walls using soil nails or ground anchors or shall have completed the construction of two or more projects totaling at least 15,000 square feet of retaining wall with a minimum total of 500 soil nails or ground anchors.

The Contractor shall assign an engineer with at least three years of experience in the design and construction of permanently anchored or nailed structures to supervise the work. The Contractor shall not use consultants or manufacturer's representatives in order to meet the requirements of this section. Drill operators and on-site supervisors shall have a minimum of one year experience installing permanent soil nails or ground anchors.

Submittals

Work shall not begin on any soil nail wall system until all of the required submittals have been approved by the Engineer. The Engineer may suspend the soil nailing work if the Contractor substitutes unqualified personnel or materials for approved personnel or materials during construction. If work is suspended due to substitutions, the Contractor shall be fully liable for additional costs resulting from the suspension of work and no adjustment in contract time

resulting from the suspension of work will be allowed. The Contractor shall submit the following information, in writing, to the Engineer not less than 30 working days prior to the start of wall excavation.

1. A brief description of each project satisfying the Contractors Experience Requirements with the Owner's name and current phone number.

2. A list identifying the following personnel assigned to this project and their experience with permanently anchored or nailed structures:

   A. Supervising Engineer

   B. Drill Operators

   C. On-site Supervisors who will be assigned to the project.

3. The proposed detailed construction procedure which includes:

   A. Proposed method(s) of excavation of the soil and/or rock.

   B. A plan for the removal and control of groundwater encountered during excavation, drilling, and other earth moving activities. Include a list of the equipment used to remove and control groundwater.

   C Proposed drilling methods and equipment. The proposed equipment and methods shall consider the construction clearances available beneath the bridge.

   D. Proposed hole diameter(s).

   E. Proposed method of soil nail installation.

   F. Grout mix design and procedures for placing the grout.

   G. Shotcrete mix design with compressive strength test results.

H. Procedures for placing the shotcrete (include placement in conditions when ground water is encountered).

4. Detailed plans of the method proposed for the soil nail testing which includes:

A. All necessary drawings and details to clearly describe the proposed system of jacking support, framing, and bracing to be used during testing.

B. Calibration data for each load cell, test jack, pressure gauge, stroke counter on the grout pump, and master gauge to be used. The calibration tests shall have been performed by an independent testing laboratory, and tests shall have been performed within 60 calendar days of the date submitted. Testing or work shall not commence until the Engineer has approved the load cell, jack, pressure gage, and master pressure gauge calibrations.

6. Certified mill test results and typical stress-strain curves along with samples from each heat, properly marked, for the soil nail steel. The typical stress-strain curve shall be obtained by approved standard practices. The guaranteed ultimate strength, yield strength, elongation, and composition shall be specified.

The soil nailed wall shall be constructed as follows:

Earthwork

The ground contour above the wall shall be established to is final configuration and backslope as shown in the Plans prior to beginning excavation of the soil for the first row of soil nails.

The excavation shall proceed from the top down in a horizontal lift sequence with the ground level excavated no more than ~~8~~ 2 feet below the elevation of the row of nails to be installed in that lift. The excavated vertical wall face should not be left open more than 24 hours for any reason. A lift shall not be excavated until the nail installation and reinforced shotcrete placement for the preceding lift has been completed and accepted. After a lift is excavated, the cut surface shall be cleaned of all loose materials, mud, rebound, and other foreign matter that could prevent or reduce shotcrete bond.

Soil Nail Storage and Handling

Soil nails shall be handled and sorted in such a manner as to avoid damage or corrosion. Prior to inserting a soil nail in the drilled hole, the Contractor and the Engineer will examine the soil nail for damage. If in the opinion of the Engineer, the ~~epoxy coating~~ corrosion protection or bar have been damaged, the nail shall be repaired. If in the opinion of the Engineer, the damage is beyond repair, the soil nail shall be rejected.

If, in the opinion of the Engineer, the ~~epoxy coating~~ corrosion protection can be repaired, the Contractor shall ~~patch the coating with an Engineer approved patching material~~ repair the corrosion protection using a manufacturer's recommended method & material, as approved by the Engineer.

Installation of Soil Nails

Nail holes shall be drilled at the locations shown in the Plans or as directed by the Engineer. The nails shall be positioned plus or minus 6 inches from the theoretical location shown in the Plans. The Contractor shall select the drilling method and the grouting pressure used for the installation of the soil nail. The drill hole shall be located so that the longitudinal axis of the drill hole and the longitudinal axis of the nail are parallel. At the point of entry the soil nail shall be installed within plus or minus three degrees of the inclination from horizontal shown in the Plans, and the nail shall be within plus or minus three degrees of a line drawn perpendicular to the face of the wall unless otherwise shown in the Plans.

The Contractor shall be prepared to encounter difficult drilling conditions. Cobbles and boulders may be present. The Contractor should review the Geotechnical Report for more information. Copies of the Geotechnical Report are available at the Project Engineer's office for the prospective bidder's review.

Water or other liquids shall not be used to flush cuttings during drilling, but air may be used. After drilling, the nail shall be installed and fully grouted before placing the structural layer of reinforced shotcrete. The nail shall be inserted into the drilled hole with centralizers to the desired depth without difficulty in such a manner as to prevent damage to the drilled hole, sheathing or epoxy during installation. When the soil nail cannot be completely inserted into the

drilled hole, the Contractor shall remove the nail from the drilled hole and clean or redrill the hole to permit insertion. Partially inserted soil nails shall not be driven or forced into the hole. Subsidence, or any other detrimental impact from drilling shall be cause for immediate cessation of drilling and repair of all damages at the Engineer's direction and the Contractor's expense.

If caving conditions are encountered, no further drilling will be allowed until the Contractor selects a method to prevent ground movement. The Contractor may use temporary casing. The Contractor's method to prevent ground movement shall be approved by the Engineer. The casings for the nail holes, if used, shall be removed as the grout is being placed.

Where necessary for stability of the excavation face, a sealing layer of shotcrete may be placed before drilling is started, or the Contractor shall have the option of drilling and grouting of nails through a stabilizing berm of native soil at the face of the excavation. The stabilizing berm shall extend horizontally from the soil face and from the face of the shotcrete a minimum distance of one foot, and shall be cut down from that point at a safe slope, no steeper than 1H:1V unless approved by the Engineer. The berm shall be excavated to final grade after installation and full length grouting of the nails. Nails damaged during berm excavation shall be repaired or replaced by the Contractor, to the satisfaction of the Engineer, at no added cost to the Contracting Agency.

If sections of the wall are constructed at different times than the adjacent soil nail sections, the Contractor shall use stabilizing berms, temporary slopes, or

other measures, as approved by the Engineer, to prevent sloughing or failure of the adjacent soil nail sections.

If cobbles and boulders are encountered at the soil face during excavation, the Contractor shall remove all cobbles and boulders that protrude from the soil face into the design wall section and fill the void with shotcrete. All shotcrete used to fill voids created by removal of cobbles and boulders shall be incidental to shotcrete wall facing.

Grouting

The Contractor shall use a neat cement grout or a sand-cement grout. The cement shall not contain lumps or other indications of hydration. Admixtures if used, shall be mixed in accordance with the manufacturer's recommendations. The cement shall comply with Section 9-01.

The grout equipment shall produce a grout free of lumps and undispersed cement. A positive displacement grout pump shall be used. The pump shall be equipped with a pressure gauge to monitor grout pressures and a stroke counter. The pressure gauge shall be capable of measuring pressures of at least 150 psi or twice the actual grout pressures used by the Contractor, whichever is greater. The grouting equipment shall be sized to enable the grout to be pumped in one continuous operation. The mixer shall be capable of continuously agitating the grout.

The grout shall be injected from the lowest point of the drilled hole. The grout shall be pumped through grout tubes after insertion of the soil nail. The

quantity of the grout and the grout pressures shall be recorded. The grout pressures and grout takes shall be controlled to prevent excessive ground heave.

Prefabricated Drainage Material

Vertical prefabricated drains, centered between the columns of nails as shown in the Plans, shall be installed before any shotcrete is placed. The permeable drain side shall be placed against the exposed soil face. The prefabricated drains shall be installed after each excavation lift and shall be hydraulically connected with the prefabricated drain previously placed, such that the vertical flow of water is not impeded.

Securing Soil Nails

Each soil nail shall be secured at the shotcrete wall facing with a steel plate as shown in the Plans. The plate shall be seated on a wet grout pad of a pasty consistency similar to that of mortar for brick-laying. The nut shall then be sufficiently tightened to achieve full bearing surface behind the plate. After the shotcrete and grout have had time to gain the specified strength, the nut shall be tightened with at least 100 ft.-lbs. of torque.

Nail Testing And Acceptance

Both verification and proof testing of the nails is required. The Contractor shall supply all materials, equipment, and labor to perform the tests. The Contractor shall submit all test data to the Engineer.

The testing equipment shall include a dial gauge or vernier scale capable of measuring to 0.001 inch of the ground anchor movement. A hydraulic jack and pump shall be used to apply the test load. The movement-measuring device shall have a minimum travel equal to the theoretical elastic elongation of the total nail length plus 1 inch. The dial gauge or vernier scale shall be aligned so that its axis is within 5 degrees from the axis of the nail and shall be monitored with a reference system that is independent of the jacking system and excavation face.

The jack and pressure gauge shall be calibrated by an independent testing laboratory as a unit. The pressure gauge shall be graduated in 100 psi increments or less. The pressure gauge will be used to measure the applied load in addition to an electronic load cell. The ram travel of the jack shall not be less than the theoretical elastic elongation of the total length at the maximum test load plus 1 inch. The jack shall be independently supported and centered over the nail so that the nail does not carry the weight of the jack. A calibrated master pressure gauge shall also be kept at the site. The master gauge shall be calibrated with the test jack and pressure gauge. The loads on the nails during the verification & proof tests shall be monitored with an electric load cell. The Contractor shall provide the electric load cell, the readout device, and a recent calibration curve. The stressing equipment shall be placed over the nail in such a manner that the jack bearing plates, load cell and stressing anchorage are in alignment.

Nails to be tested shall be initially grouted no closer to the excavation face than the dimension shown in the Plans. After placing the grout, the nail shall remain

undisturbed until the grout has reached a strength sufficient to provide resistance during testing. Grouting to the excavation face shall be completed after successful testing has been performed. Test nails which are not part of the permanent wall may be left in the ground, provided the drill holes for the nails are completely filled with grout or non structural filler after testing.

Load testing shall be performed against a temporary bearing yoke or reaction frame which bears directly against the existing soil or the shotcrete facing. Temporary bearing pads shall be kept a minimum of 12 inches from the edges of the drilled hole unless a rigid steel plate is used to distribute the stress around the drilled hole. If a steel plate is used, it shall be a minimum of 3 feet square and of sufficient thickness that it will distribute the load evenly to the soil. Where the reaction frame bears directly against the shotcrete, the reaction frame shall be designed to prevent fracture of the shotcrete. No part of the reaction frame shall bear within 12 inches of the edge of the test nail blockout unless otherwise approved by the Engineer.

Verification Testing

Verification testing shall be performed on nails installed within the pattern of production nails to verify the Contractor's procedures, hole diameter, and design assumptions. No drilling or installation of production nails will be permitted in any ground/rock unit unless successful verification testing of anchors in that unit has been completed and approved by the Engineer, using the same equipment, methods, nail inclination, nail length, and hole diameter as planned for the production nails. Changes in the drilling or installation method may require additional verification testing as determined by the

Engineer and shall be done at the Contractor's expense. Verification tests can be performed prior to excavation for the soil nail wall.

Successful verification tests are required within the limits as listed in the following table. Test nail locations within these limits shall be at locations selected by the Engineer.

Verification Test Limits	Number of Successful Verification Test Required
Between W7 Sta. 14+14 and ~~W7~~ W7 Sta. 14+32	1 test in top row
Between W7 Sta. 15+28 and W7 Sta. 15+52	1 test in top row
Between W7 Sta 14+14 & W7 Sta. 14+32	1 test in Row 2 at Design Load Transfer = 2.5 kips per foot.

The design details of the verification testing, including the system for distributing test load pressures to the excavation surface and appropriate nail bar size and reaction plate, shall be developed by the Contractor, subject to approval by the Engineer. The intent is to stress the bond between the grout and the surrounding soil/rock to at least twice the design load transfer.

The bar shall be proportioned such that the maximum stress at 200 percent of the test load does not exceed 80 percent of the yield strength of the steel. The jack shall be positioned at the beginning of the test such that unloading and repositioning of the jack during the test will not be required. The verification tests shall be made by incrementally loading the nails in accordance with the following schedule of hold time:

AL	1 minute
0.25TL	10 minutes
0.50TL	10 minutes
0.75TL	10 minutes
1.00TL	10 minutes
1.25TL	10 minutes
1.50TL	60 minutes
1.75TL	10 minutes
2.00TL	10 minutes_

AL = Nail Alignment Load

TL = Nail Test Load

The test load shall be determined by the following equation = Test Load (TL) = Bond Length (BL) X Design Load Transfer (DLT).

The load shall be applied in increments of 25 percent of the test load. Each load increment shall be held for at least 10 minutes. Measurement of nail movement shall be obtained at each load increment. The load-hold period shall start as soon as the load is applied and the nail movement with respect to a fixed reference shall be measured and recorded at 1 minute, 2, 3, 5, 6, 10, 20, 30, 50, and 60 minutes.

The Engineer will evaluate the results of each verification test and make a determination of the suitability of the test and of the Contractor's proposed production nail design and installation system. Tests which fail to meet the design criteria will require additional verification testing or an approved revision to the

Contractor's proposed production nail design and installation system. If a nail fails in creep, retesting will not be allowed.

A verification tested nail with a 60 minute load hold at 1.50TL is acceptable if:

1. The nail carries the test load with a creep rate that does not exceed 0.08 inch per log cycle of time and is at a linear or decreasing creep rate.

2. The total movement at the test load exceeds 80 percent of the theoretical elastic elongation of the non-bonded length.

Furthermore, a pullout failure must not occur for the verification test anchor at the 2.0TL maximum load. Pullout failure load is defined as the load at which attempts to increase the test load result only in continued pullout movement of the test nail without a sustainable increase in the test load.

The nails used for verification tests shall be sacrificial and shall not be used for production.

Proof Testing

Proof tests shall be performed on production nails at the locations selected by the Engineer. Up to five percent of the production nails will be tested. Prior to testing, only the bond length (BL) portion of the nail shall be grouted. The Contractor shall maintain the side-wall stability of the drill hole for the non-grouted portion during the test. Once proof testing is completed, the remainder

of the proof tested nail shall be grouted. The bond length shall be determined from the Nail Schedule and Test Nail Detail shown in the Plans.

Proof tests shall be performed by incrementally loading the nail in accordance with the schedule below. The anchor movement shall be measured and recorded to the nearest 0.001 inch with respect to an independent fixed reference point in the same manner as for the verification tests at the alignment load and at each increment of load. The load shall be monitored with a pressure gauge and electronic load cell. The scheduling of hold times shall be as follows:

- AL	1 minute
0.25TL	5 minutes
0.50TL	5 minutes
0.75TL	5 minutes
1.00TL	5 minutes
1.25TL	5 minutes
1.50TL	10 minutes

AL = Nail Alignment Load

TL = Nail Test Load

The maximum load in a proof test shall be held for 10 minutes. The load hold period shall start as soon as the maximum load is applied and the nail movement with respect to an independent fixed reference shall be measured and recorded at 1, 2, 3, 4, 5, 6, and 10 minutes. The nail movement between 1 minute and 10 minutes shall not exceed 0.04 inches. If the nail movement

between 1 and 10 minutes exceeds 0.04 inches, the maximum load shall be held an additional 50 minutes. If the load hold is extended, the nail movement shall be recorded at 20, 30, 50, and 60 minutes. If a nail fails in creep, retesting will not be allowed.

A proof tested nail is acceptable if:

1. The nail carries the maximum load with less than 0.04 inches of movement between 1 minute and 10 minutes, unless the load hold extended to 60 minutes, in which case the nail would be acceptable if the creep rate does not exceed 0.08 inches per log cycle of time.

2. The total movement at the maximum load exceeded 80 percent of the theoretical elastic elongation of the non-bonded length.

3 The creep rate is not increasing with time during the load hold period.

Due to the requirement for a non-bonded zone for testing purposes, the contractor shall develop an installation method which will assure the stability of the non-bonded portion of the hole during testing and will allow for the non bonded zone to be grouted against the ground after testing.

If a proof test fails, the Engineer may direct the Contractor to replace some or all of the installed production nails between the failed test and an adjacent proof test nail that has met the test criteria. The Engineer may also require

additional proof testing. Costs associated with additional proof tests or installation of additional or modified nails shall be at the Contractor's expense.

Tolerances

The accuracy of the ground cut shall be such that the required thickness of shotcrete can be placed within a tolerance of plus or minus 2 inches from the defined face of the wall, and over excavation does not damage overlying shotcrete sections by undermining or other causes.

The shotcrete shall be constructed to the minimum thickness as shown in the Plans. Costs associated with additional thickness of shotcrete due to over excavation or irregularities in the cut face shall be borne by the Contractor.

Asphalt Concrete Gutter

Asphalt concrete gutter shall be constructed as shown in the Plans and as specified in Section 8-04.

Measurement

Soil nails will be measured per each, including all drilling, grouting, centralizers, bearing plates, welded shear connectors, nuts, and other work required for installation of each soil nails.

All excavation for the walls has been calculated in the quantity of roadway excavation including haul and select roadway excavation for stockpile including haul.

No specific measurement will be made for nail proof testing, which shall be incidental to production nails.

Shotcrete wall facing will be measured by the square foot of area placed and accepted, including embedded welded wire fabric and steel reinforcing bar.

Concrete fascia wall will be measured by the square foot of completed and accepted fascia area, including steel reinforcing bar, architectural finish if shown on the Plans, and pigmented sealer.

Prefabricated drainage material will be measured by the square yard of material furnished and installed.

Verification Testing will be measured per each for each soil nail tested.

Asphalt concrete gutter will be measured by the linear foot of gutter installed along the survey stationing of the soil nail wall.

Payment

Payment will be made for each of the following bid items included in the proposal:

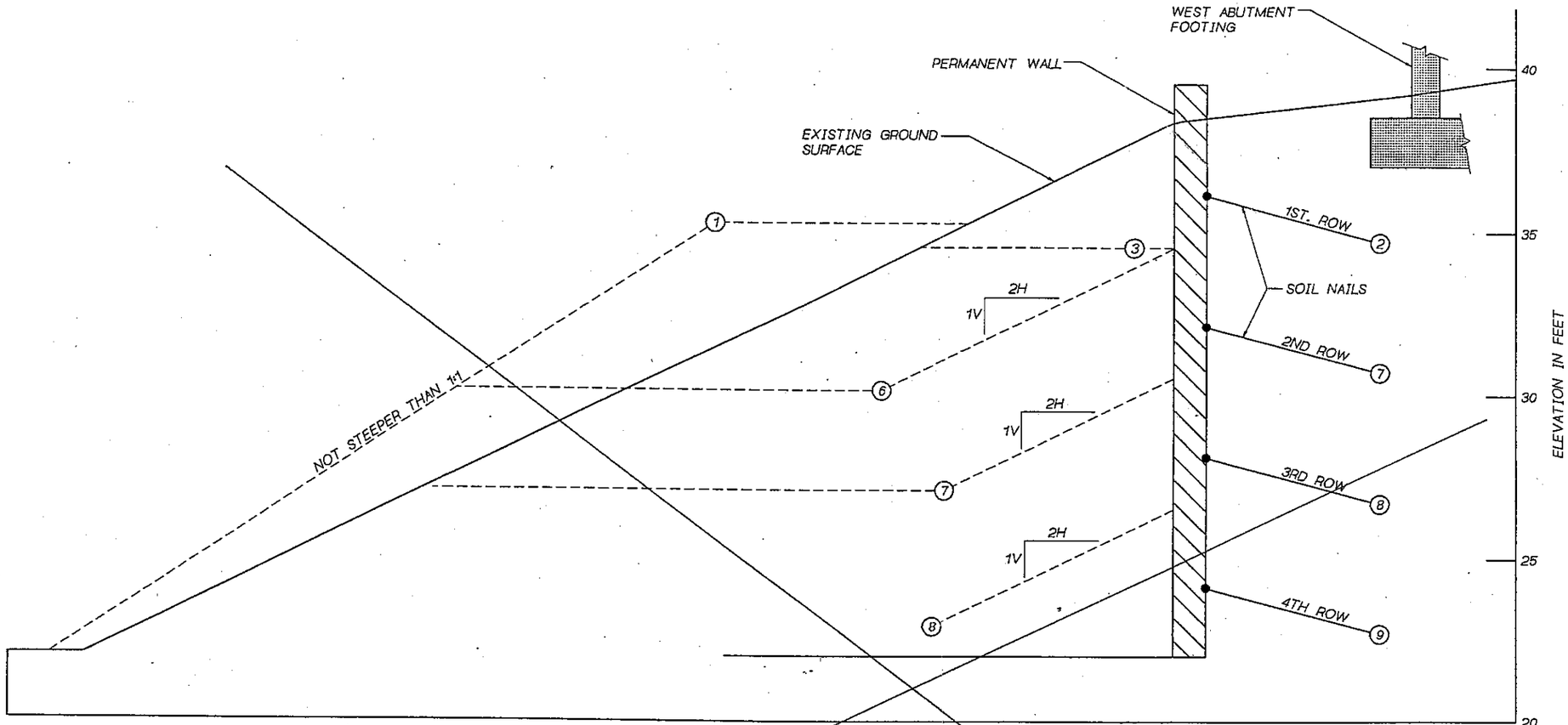
1. "Soil Nail", per each.
2. "Shotcrete Wall Facing", per square foot.
3. "Concrete Fascia Wall", per square foot.

4. "Prefabricated Drainage Material", per square yard.

5. "Verification Test", per each.

6. "Asphalt Conc. Gutter", per linear foot.

For the purpose of payment, such wall items as pressure treated timber, premolded joint filler, polyethylene bond breaker strip, joint sealant, pvc pipe etc., for which there is no pay item included in the proposal, are considered as wall minor items. All costs in connection with furnishing and installing these wall minor items as shown and noted in the Plans and as outlined in these specifications and in the Standard Specifications shall be included in the applicable adjacent items of work.



CONSTRUCTION SEQUENCE

UNDER EXIST. BRIDGE ABUTMENT
W7 STA. 14+35 TO W7 STA. 15+19
LOOKING BACK ON STATIONING.

DELETE SHEET

NOTES:

1. CONSTRUCT BERM TO INSTALL FIRST NAIL ROW.
2. INSTALL NAILS.
3. EXCAVATE ALTERNATE SLOTS ALONG THE WALL AT MAXIMUM LENGTH OF 12 FEET.
4. PLACE DRAINAGE MAT., SHOTCRETE AND PRESTRESS NAILS.
5. EXCAVATE REMAINING SLOTS, PLACE DRAINAGE MAT., SHOTCRETE AND PRESTRESS NAILS.
6. EXCAVATE 2H:1V SLOPE FROM BASE OF SHOTCRETE TO NEXT BERM LEVEL. TOP OF BERM SHOULD BE NO LOWER THAN 2 FEET BELOW THE LAST ROW OF COMPLETED NAILS.
7. REPEAT 2, 3, 4, 5 AND 6.
8. REPEAT 2, 3, 4, 5 AND 6.
9. REPEAT 2, 3, 4 AND 5.

Bridge Design Engr. C. C. RUTH		WALLGROOT:[FGB]SEQ.FGB;1			REGION NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS	BRIDGE AND STRUCTURES OFFICE	
Supervisor Y. A. MHATRE					10	WASH.				MOHAMMAD SHEIKHZADEH STATE OF WASHINGTON 23909 REGISTERED PROFESSIONAL ENGINEER EXPIRES 3/19/99	MONINDRA TALUKDAR STATE OF WASHINGTON 37625 REGISTERED PROFESSIONAL ENGINEER EXPIRES 6/1/00
Designed By M. SHEIKIZADEH 6/98					JOB NUMBER 93W047						
Checked By K.S. KOH 6/98											
Detailed By J. PLESHA 6/98											
Bridge Projects Engr.											
Prelim. Plan By											
Architect/Specialist	DATE	REVISION	BY	APP'D							

12-AUG-98

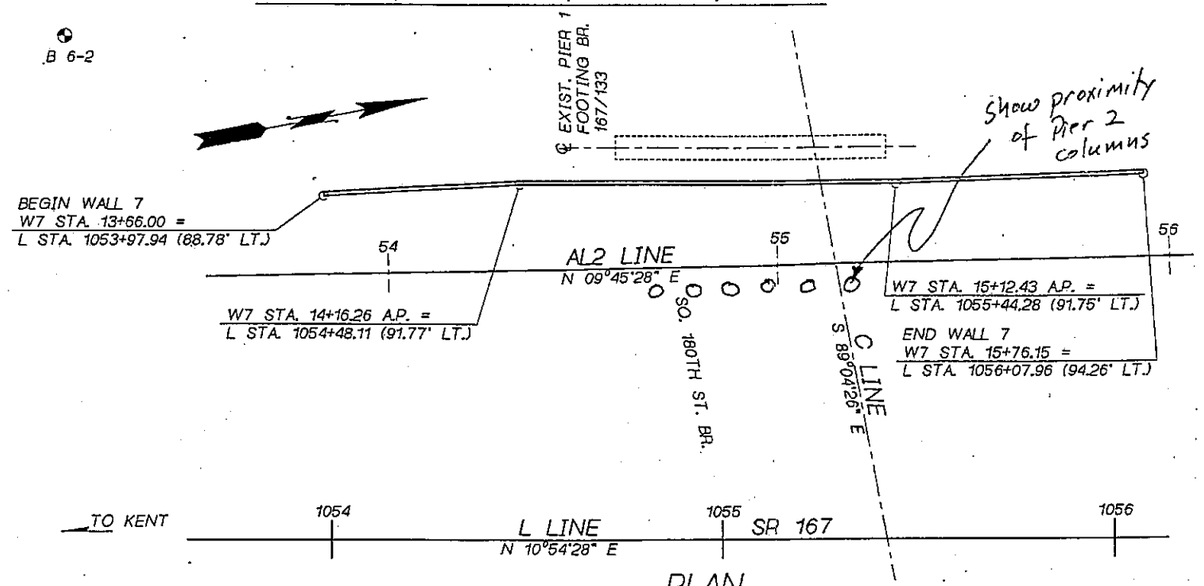
Washington State Department of Transportation

SR 167
15TH ST. SW TO 15TH ST. NW
HOV LANES - STAGE 3

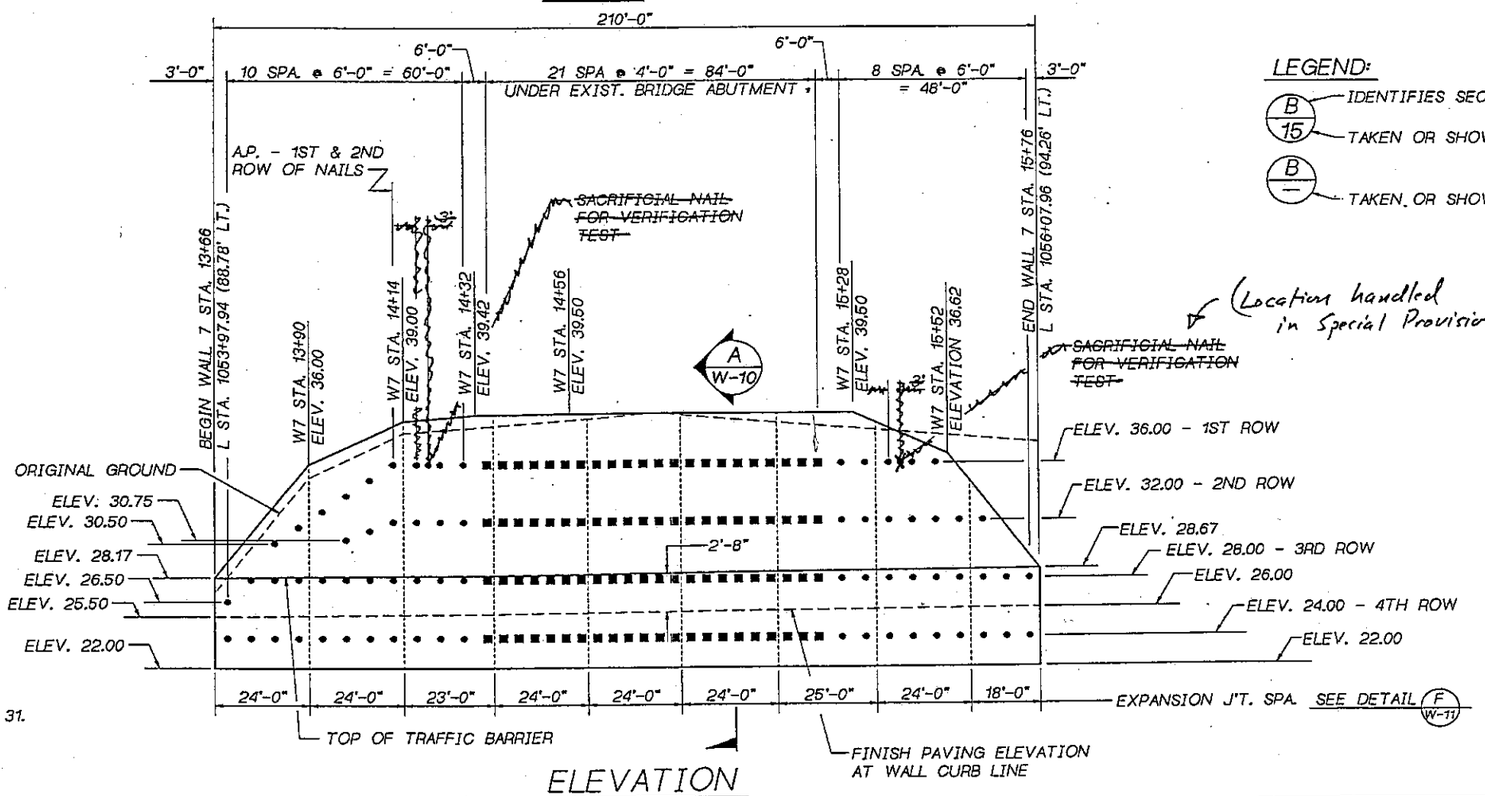
CONSTRUCTION SEQUENCE

BRIDGE SHEET NO. W-8
SHEET OF SHEETS

SEC. 31, T. 23 N., R. 5 E., W.M.



PLAN



ELEVATION

GENERAL NOTES

1. ALL MATERIAL AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR ROAD, BRIDGES AND MUNICIPAL CONSTRUCTION DATED 1991 AND AMENDMENTS.
2. THE RETAINING WALL HAS BEEN DESIGNED IN ACCORDANCE WITH THE REQUIREMENTS OF LOAD FACTOR DESIGN AND A SEISMIC ACCELERATION COEFFICIENT OF 0.15 HORIZONTAL HAS BEEN USED.
3. ALL SHOTCRETE AND C.I.P. CONCRETE SHALL ATTAIN A 28 DAY MIN. COMPRESSIVE STRENGTH OF 4000 PSI.
4. THE SHOTCRETE WALL SHALL HAVE A MIN. COMPRESSIVE STRENGTH OF 2500 PSI BEFORE SOIL NAILS CAN BE STRESSED.
5. UNLESS OTHERWISE SHOWN ON THE PLANS, CONCRETE COVER MEASURED FROM THE FACE OF THE CONCRETE TO THE FACE OF ANY REINFORCEMENT BAR SHALL BE 1½ INCHES.

LEGEND:

- B / 15 — IDENTIFIES SECTION, VIEW OR DETAIL TAKEN OR SHOWN ON BRIDGE SHEET 15
- B / — TAKEN OR SHOWN ON THE SAME SHEET

- INDICATES EPOXY COATED GR. 60 REBAR AASHTO M 31. TOTAL REQ'D = 69. (INCL. SACRIFICIAL NAILS)
- INDICATES 1"ϕ HIGH STRENGTH EPOXY COATED BAR AASHTO M 275 TYPE II. TOTAL REQ'D = 88.

Bridge Design Engr. C. C. RUTH	WALLGROOT:(FGB)LAYOUT.FGB:1		
Supervisor Y. A. MHATRE			
Designed By M. SHEIKIZADEH 6/98			
Checked By K.S. KOH 6/98			
Detailed By J. PLESHA 6/98			
Bridge Projects Engr.			
Prelim. Plan By			
Architect/Specialist	DATE	REVISION	BY APP'D

REGION NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
10	WASH.			
JOB NUMBER 93W047				

BRIDGE AND STRUCTURES OFFICE

TONY M. ALLEN — STATE OF WASHINGTON — 25026 — REGISTERED PROFESSIONAL ENGINEER — EXPIRES 3/1/99

MUNINDRA TALUKDAR — STATE OF WASHINGTON — 27629 — REGISTERED PROFESSIONAL ENGINEER — EXPIRES 6/1/00

Washington State Department of Transportation

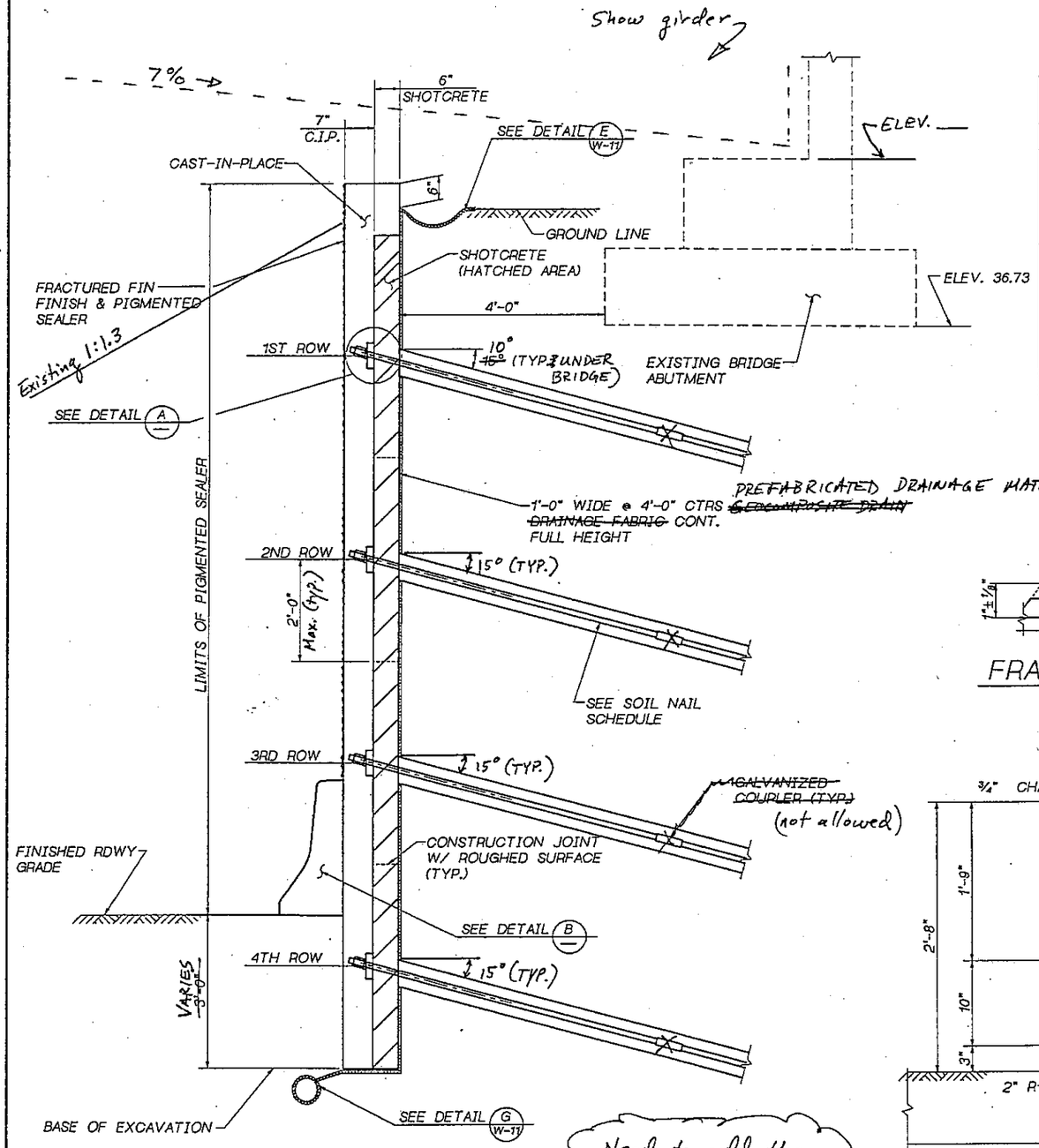
SR 167
15TH ST. SW TO 15TH ST. NW
HOV LANES - STAGE 3

WALL 7 LAYOUT

BRIDGE SHEET NO. W-7
SHEET OF SHEETS

SH 167 JOB NO. ____ SHEET W-7

12-AUG-98



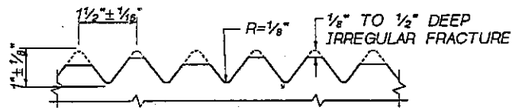
TYPICAL WALL GEOMETRY

Need to add the Fully Encapsulated Nail Detail

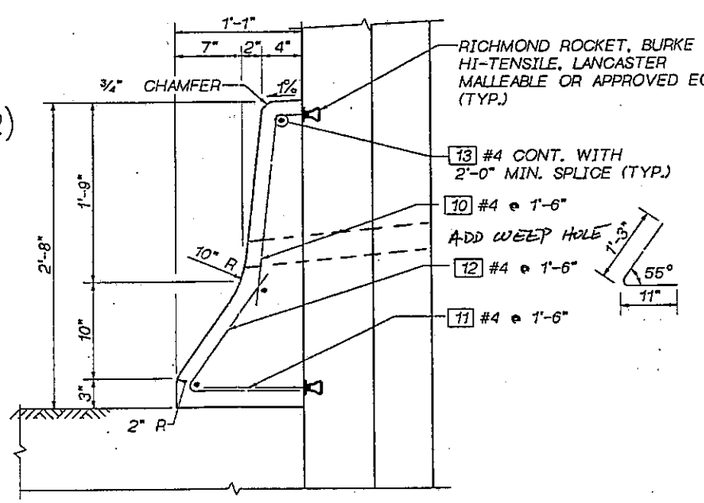
SOIL NAIL SCHEDULE

	ROW	NAIL HOLE DIA. (IN.)	NAIL SIZE	MIN. LENGTH (FT.)	MIN. ~~ALLOWABLE~~ DESIGN LOAD TRANSFER (K/')	DESIGN LOAD (K)	VERIFICATION TEST LOAD (K)	PROOF TEST LOAD (K)	JACKING FORCE (K)
UNDER EXIST. BR. ABUTMENT	1	~~6~~ 5	1" ϕ H.S. BAR	~~54~~ 28	~~18~~ 1.5	59	-	89	25
	2	~~6~~ 5	1" ϕ H.S. BAR	~~35~~ 28	~~18~~ 2.5	38	-	57	25
	3	~~6~~ 5	1" ϕ H.S. BAR	~~35~~ 28	~~18~~ 2.5	40	-	60	25
	4	~~6~~ 5	1" ϕ H.S. BAR	~~35~~ 28	~~18~~ 2.5	41	-	62	25
BEYOUND BR. ABUTMENT	1	~~6~~ 5	#7 REBAR	~~26~~ 16	~~18~~ 1.5	21	42	32	0
	2	~~6~~ 5	#7 REBAR	~~26~~ 16	~~18~~ 1.5	27	54	41	0
	3	~~6~~ 5	~~#7~~ #9 REBAR	~~26~~ 16	~~18~~ 2.5	32	64	48	0
	4	~~6~~ 5	~~#7~~ #9 REBAR	~~26~~ 16	~~18~~ 2.5	32	64	48	0

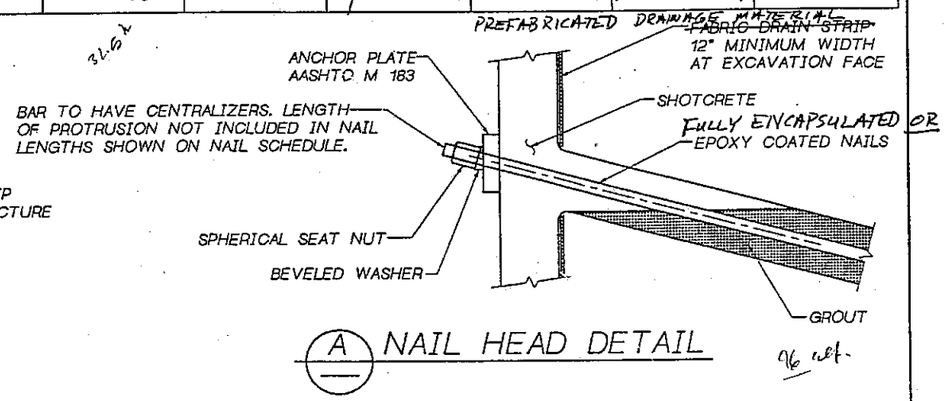
MINIMUM



FRACTURED FIN FINISH

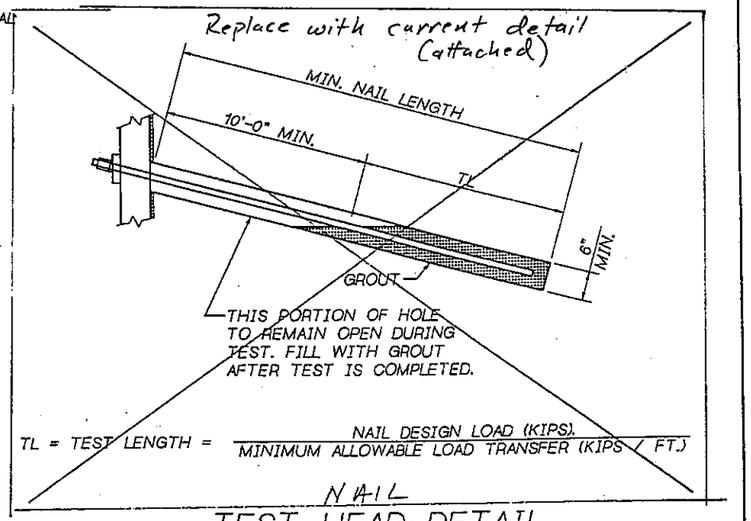


DETAIL B



A NAIL HEAD DETAIL

96 ref.



NAIL TEST ~~HEAD~~ DETAIL

Bridge Design Engr. C. C. RUTH	WALLGROUT:[FGB]TYPSEC.FGB;1			REGION NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS	BRIDGE AND STRUCTURES OFFICE
Supervisor Y. A. MHATRE				10	WASH.				TONY M. ALLEN, STATE OF WASHINGTON, 22009, REGISTERED PROFESSIONAL ENGINEER, EXPIRES 7/1/99
Designed By M. SHEIKIZADEH 6/98									MUNINDRA TALUKDAR, STATE OF WASHINGTON, 27621, REGISTERED PROFESSIONAL ENGINEER, EXPIRES 6/17/00
Checked By K.S. KOH 6/98				JOB NUMBER 93W047					
Detailed By J. PLESHA 6/98									
Bridge Projects Engr.									
Prelim. Plan By									
Architect/Specialist	DATE	REVISION	BY	APP'D					

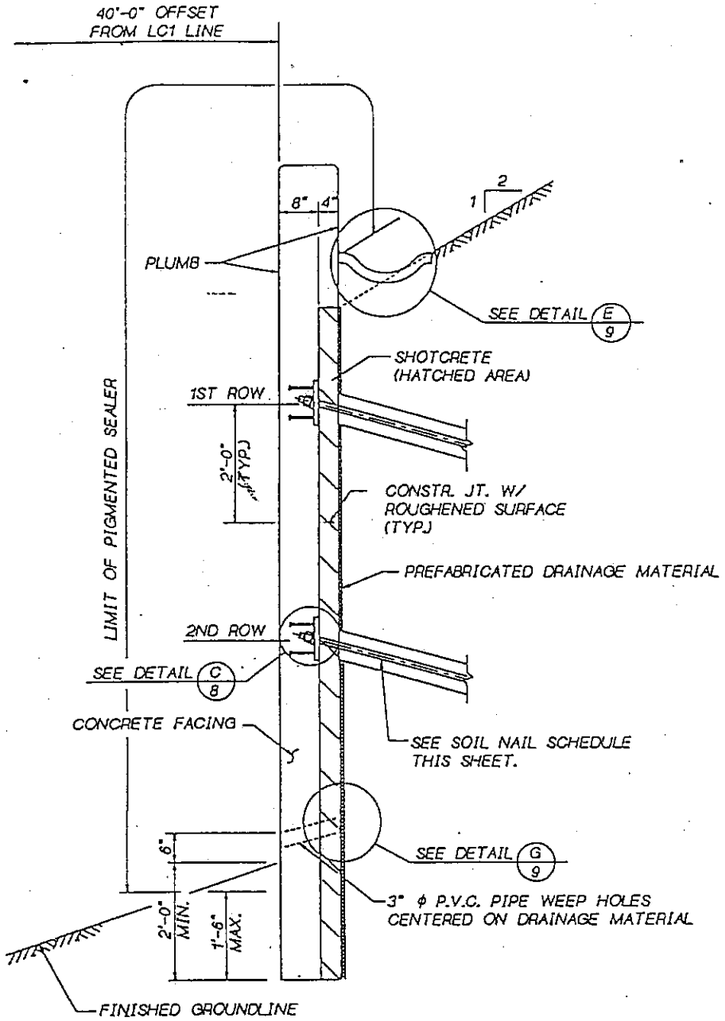
Washington State Department of Transportation

SR 167
15TH ST. SW TO 15TH ST. NW
HOV LANES - STAGE 3

TYPICAL SECTION AND NAIL DETAILS

BRIDGE. SHEET NO. W-9 SHEET OF SHEETS

SH 167 JOB NO. ____ SHEET W-9

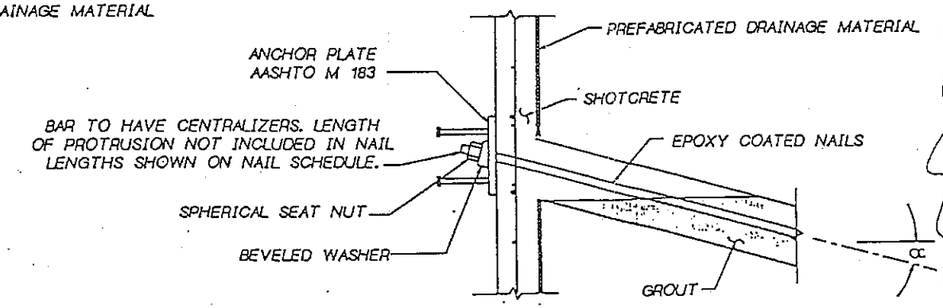


TYPICAL SECTION SOIL NAIL WALL

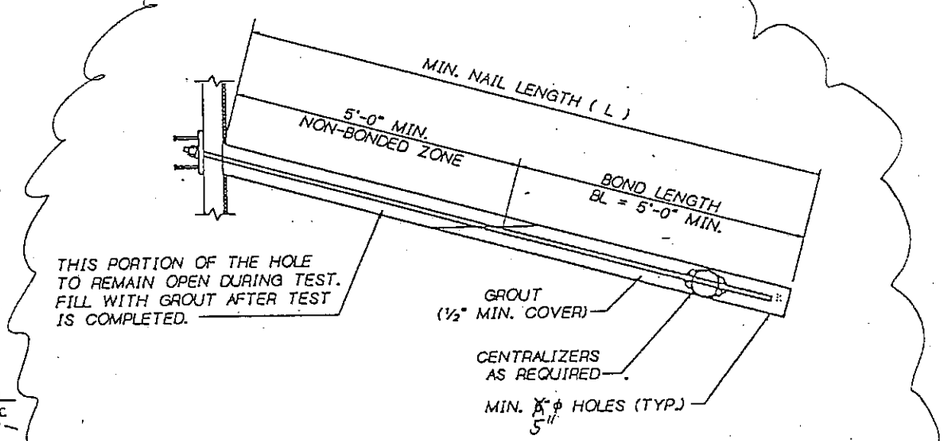
NAIL SCHEDULE						
	ROW	L	α	S	BAR #	DLT
WALL - 1						
SEGMENT A STATION 400+50 TO STATION 401+50	①	12'-0"	15°	5'-0"	#6	1.0
SEGMENT B STATION 401+50 TO STATION 407+00	①	12'-0"	15°	5'-0"	#6	1.0
	②	12'-0"	15°	5'-0"	#6	1.0
SEGMENT C STATION 407+00 TO STATION 410+25	①	12'-0"	15°	5'-0"	#6	1.0
WALL - 2						
SEGMENT D STATION 418+25 TO STATION 419+50	①	12'-0"	15°	5'-0"	#6	1.0
SEGMENT E STATION 419+50 TO STATION 425+00	①	12'-0"	15°	5'-0"	#6	1.0
	②	12'-0"	15°	5'-0"	#6	1.0
SEGMENT F STATION 425+00 TO STATION 425+75	①	12'-0"	15°	5'-0"	#6	1.0

LEGEND
⊡ = NAIL
① = ROW
L = MINIMUM NAIL LENGTH (FT.)
α = NAIL DECLINATION (DEG.)
S = HORIZONTAL NAIL SPACING (FT.)
DLT = DESIGN LOAD TRANSFER (KIPS/FT)
BAR # = MIN. STEEL BAR SIZE

NOTE: NAIL ELEVATIONS AT FACE OF SHOTCRETE ARE TO BE LINEARLY INTERPOLATED BETWEEN ELEVATIONS SHOWN ON ELEVATIONS SHEETS.



NAIL HEAD DETAIL



TEST NAIL DETAIL

Bridge Design Engr. C. C. RUTH					REGION NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
Supervisor T. M. ALLEN / Y.A. MHATRE					10	WASH.			
Designed By R. KIMMERLING & R.E. LIPTAK					JOB NUMBER				
Checked By T. ALLEN & Y.A. MHATRE									
Detailed By R.E. LIPTAK									
Bridge Projects Engr.									
Prelim. Plan By									
Architect/Specialist	DATE	REVISION	BY	APP'D					

BRIDGE AND STRUCTURES OFFICE

TONY M. ALLEN — STATE OF WASHINGTON — PROFESSIONAL ENGINEER — EXPIRES 12/17/95 — 5-8-95 STATE GEOTECHNICAL ENGINEER

CHARLES C. RUTH — STATE OF WASHINGTON — PROFESSIONAL ENGINEER — EXPIRES 5/2/95 — 5-2-95 BRIDGE DESIGN ENGINEER

Washington State Department of Transportation

TYPICAL WALL SECTIOIN AND SOIL NAIL DETAILS

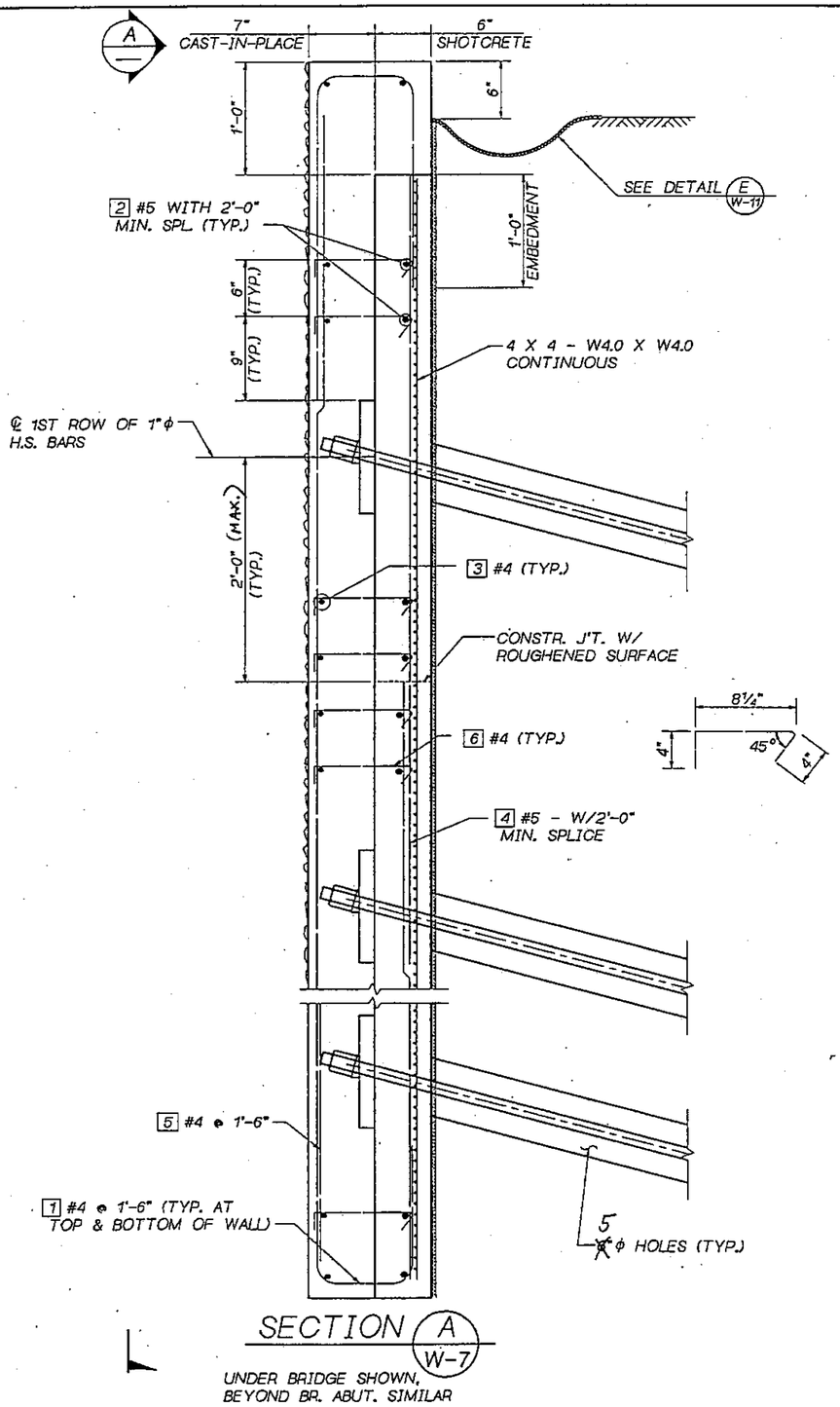
BRIDGE SHEET NO. 7

SHEET OF SHEETS

SR 522 JOB NO. ____ SHEET 7

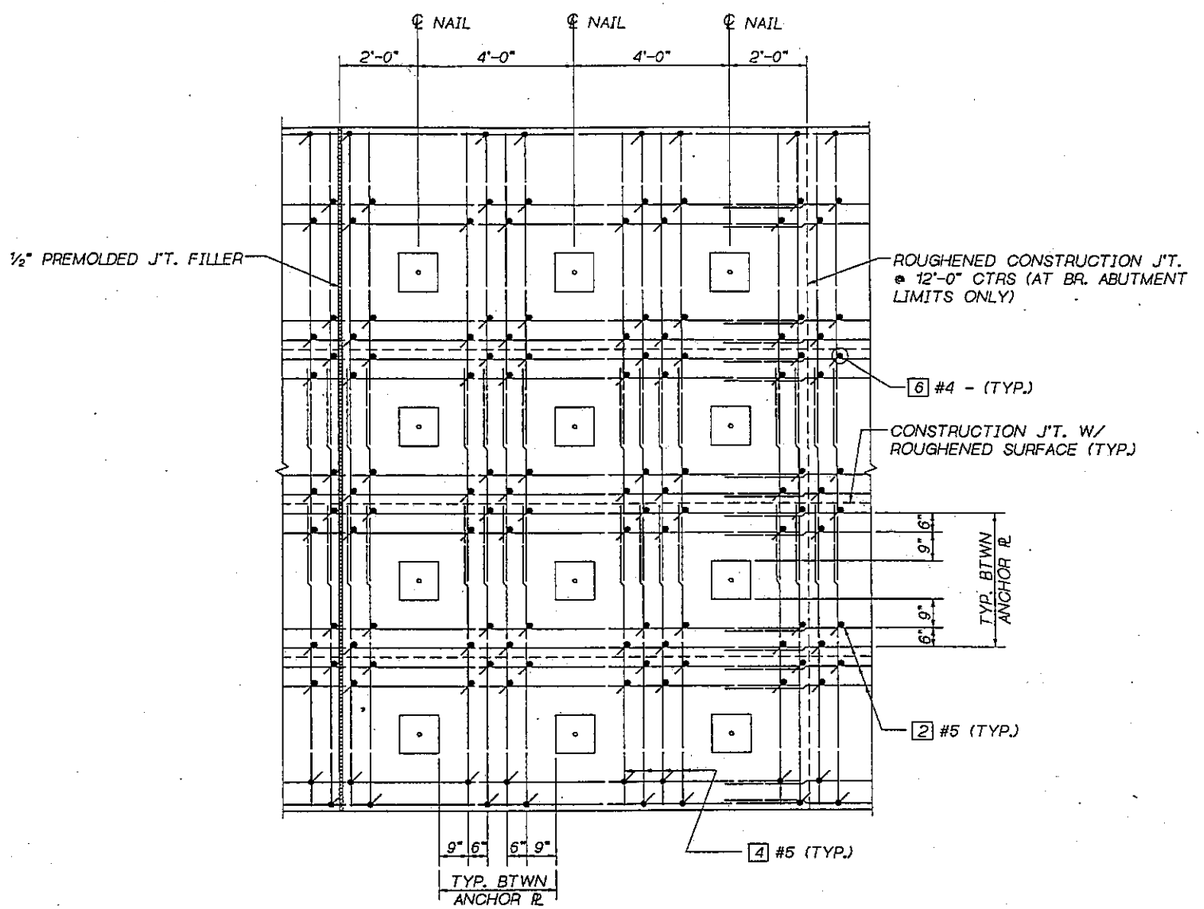
02-MAY-95

SMALL_JOBROOT:[FGB]S522_T_WALL_SEC.FGB;1



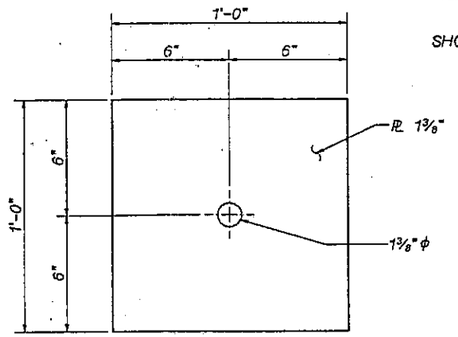
SECTION A W-7

UNDER BRIDGE SHOWN, BEYOND BR. ABUT. SIMILAR

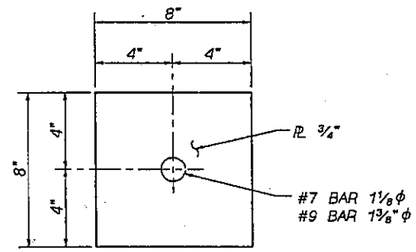


VIEW A

SHOTCRETE REINF. SHOWN



UNDER BRIDGE ABUTMENT



BEYOND BRIDGE ABUTMENT

ANCHOR PLATE DETAILS

AASHTO M 183

SR 167 JOB NO. ____ SHEET W-10

Bridge Design Engr. C. C. RUTH	WALLGROOT:(FGB)REINF.FGB:1				REGION NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
Supervisor Y. A. MHATRE					10	WASH.			
Designed By M. SHEIKIZADEH 6/98					JOB NUMBER 93W047				
Checked By K.S. KOH 6/98									
Detailed By J. PLESHA 6/98									
Bridge Projects Engr.									
Prelim. Plan By									
Architect/Specialist	DATE	REVISION	BY	APP'D					

BRIDGE AND STRUCTURES OFFICE

MOHAMMAD SHEIKHIZADEH — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER — EXPIRES 9/19/99

MUNINDRA TALUKDAR — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER — EXPIRES 6/1/00

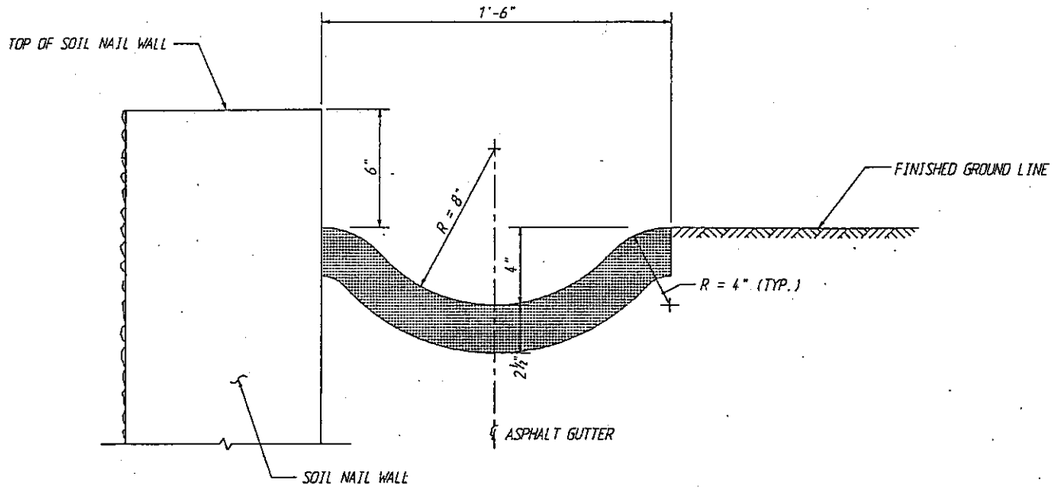
Washington State Department of Transportation

SR 167
15TH ST. SW TO 15TH ST. NW
HOV LANES - STAGE 3

WALL REINFORCEMENT

BRIDGE SHEET NO. W-10

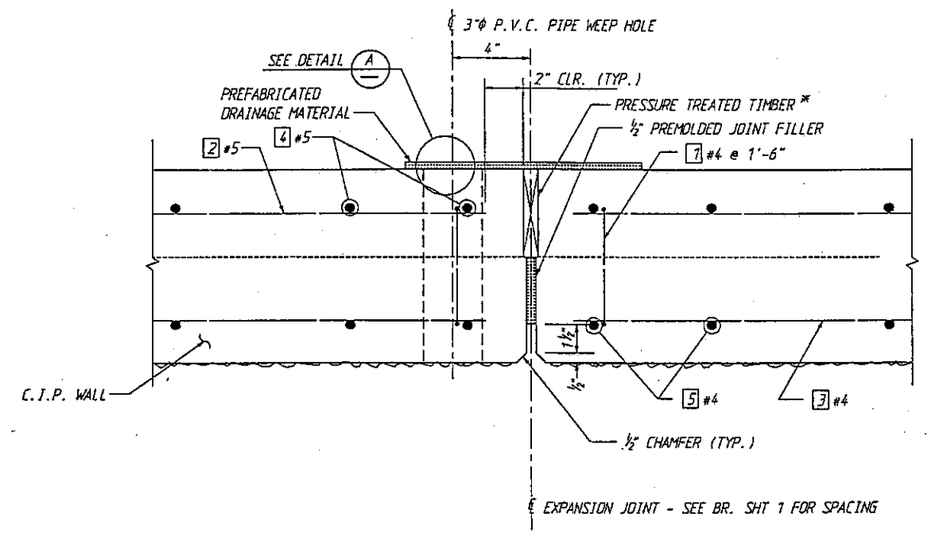
SHEET OF SHEETS



DETAIL E — W-9, W-10

TYPICAL ASPHALT GUTTER

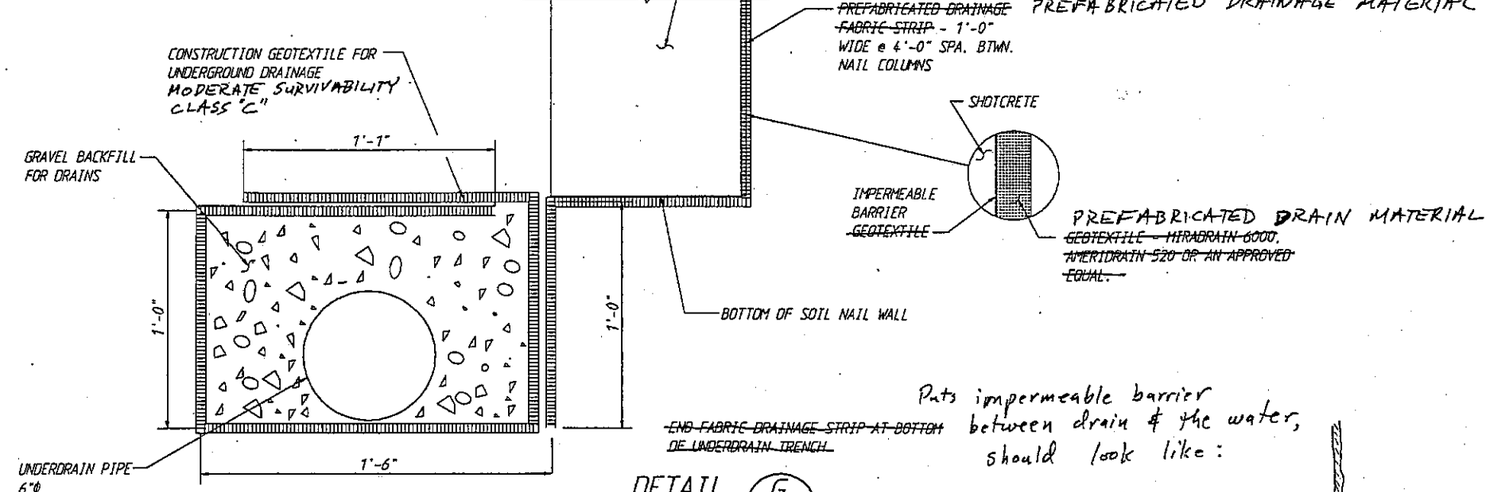
* CONTRACTOR MAY PLACE ½" PREMOLDED JOINT FILLER IN PLACE OF P.T. TIMBER.



NOTE: EXPANSION JOINTS SHALL BE LOCATED AT A MAXIMUM SPACING OF 24'-0" CTR. TO CTR.

DETAIL F — W-7

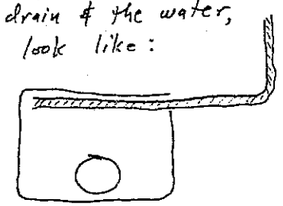
TYPICAL EXPANSION JOINT

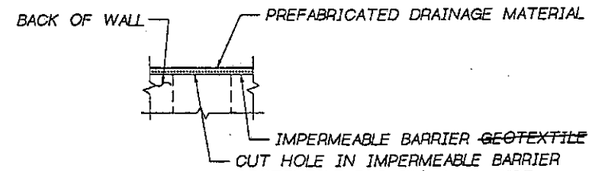


DETAIL G — W-9

TYPICAL FABRIC DRAIN CONNECTION TO PVC PIPE

Puts impermeable barrier between drain & the water, should look like:





DETAIL A

Bridge Design Engr. C. C. RUTH	WALL6ROOT:[FGB]DRAIN.FGB;1			REGION NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS	BRIDGE SHEET NO.
Supervisor Y. A. MHATRE				10	WASH.				W-11
Designed By M. SHEIKIZADEH 6/98				JOB NUMBER 93W047					SHEET OF SHEETS
Checked By K.S. KOH 6/98									
Detailed By J. PLESHA 6/98									
Bridge Projects Engr.									
Prelim. Plan By									
Architect/Specialist	DATE	REVISION	BY	APP'D					

BRIDGE AND STRUCTURES OFFICE

MOHAMMAD SHEIKHZADEH — STATE OF WASHINGTON — PROFESSIONAL ENGINEER — REGISTERED — EXPIRES 6/19/99

MUNINDRA TALUKDAR — STATE OF WASHINGTON — PROFESSIONAL ENGINEER — REGISTERED — EXPIRES 6/17/00

Washington State Department of Transportation

SR 167
15TH ST. SW TO 15TH ST. NW
HOV LANES - STAGE 3

DRAINAGE

12-AUG-98